(12) UK Patent Application (19) GB (11) 2 157 140 A

(43) Application published 16 Oct 1985

(21) Application No 8506508

(22) Date of filing 13 Mar 1985

(30) Priority data

(31) 592906 (32) 23 Mar 1984 (33) US

(51) INT CL[4]
G21K 5/10

(52) Domestic classification
H5R BC
U1S 1625 1626 2405 H5R

(56) Documents cited
EP A2 0107280

(58) Field of search
H5R

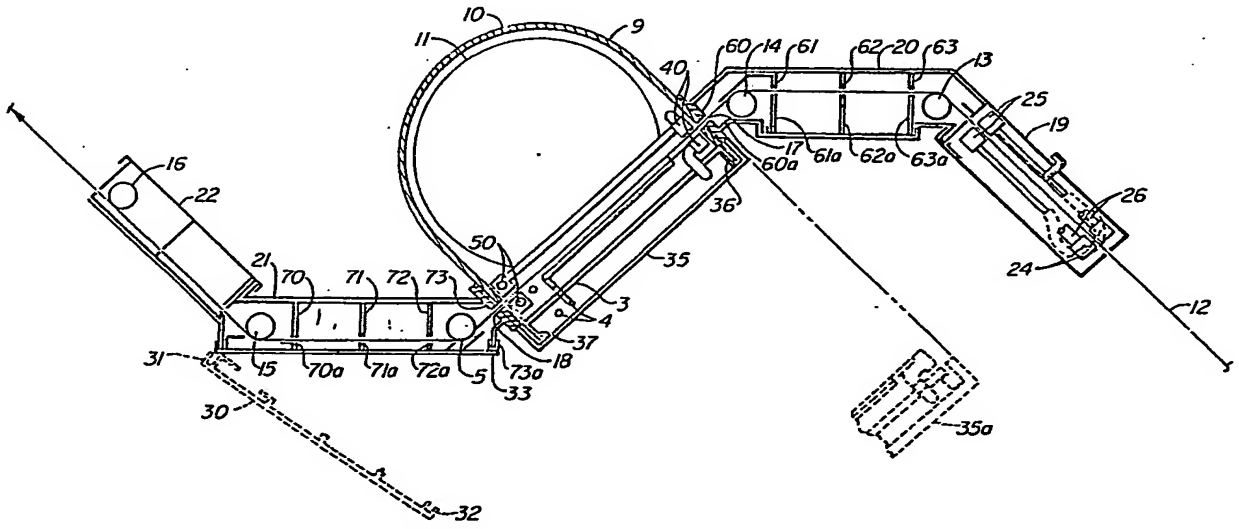
(71) Applicant
RPC Industries (USA-California),
3202 Investment Boulevard, Hayward, California 94545,
United States of America

(72) Inventors
Warren J. Ramler,
Richard G. Daigle

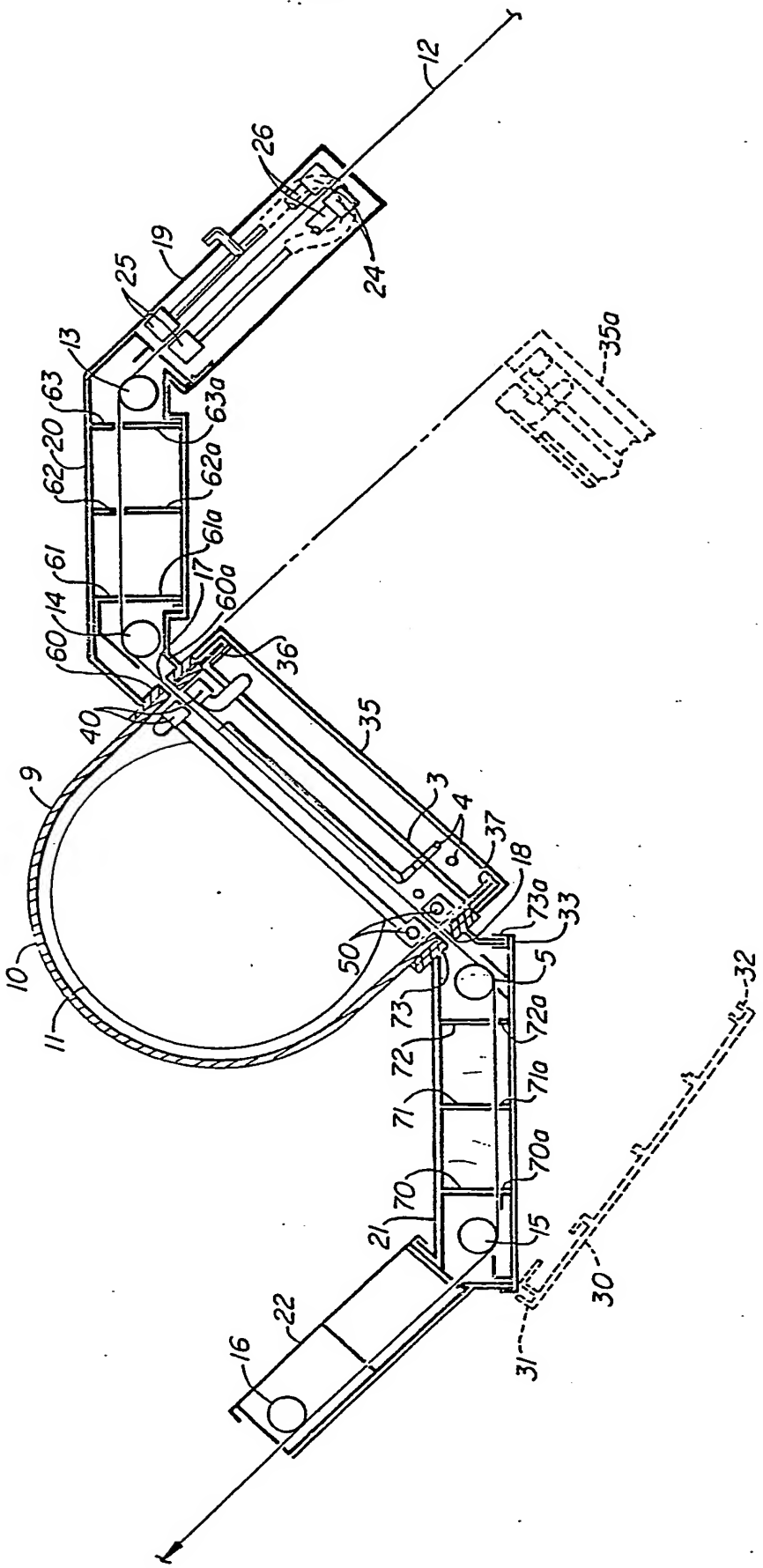
(74) Agent and/or Address for Service
J. A. Kemp & Co.,
14 South Square, Gray's Inn, London WC1R 5EU

(54) Electron beam reaction chamber

(57) An apparatus for providing ionizing radiation to a moving web or sheet 12 comprising a central chamber 10 which includes means 11 for generating and directing ionizing radiation to said moving web or sheet. Inlet and outlet means for the passage of the moving web or sheet comprise one or more subchambers 20, 21 at the inlet and outlet sides of the central chamber, said subchambers containing means 60-63a, 70-73a for trapping spurious ionizing radiation and being further characterized as being removable from adjacent subchambers and the central chamber. A radiation trap 35 is removable for access to the central chamber 10.



GB 2 157 140 A


12
26
24
19
25
13
63
63a
20
62
62a
61a
61
17
60a
14
60
36
35
40
9
3
4
37
18
73a
33
50
5
10
11
73
72
72a
71
71a
70a
70
21
15
22
16
30
31
32
35a

SPECIFICATION

Electron beam reaction chamber

Technical Field of the Invention

The present invention deals with an apparatus for providing ionizing radiation to a moving web or sheet. The radiation includes electrons, positive ions, x-rays, photons and gammas, whereby it provides a convenient containment enclosure which prevents spurious radiation from emanating to the areas surrounding the apparatus.

Background of the Invention

It has been well know for quite some time that ionizing radiation in the form of, for example, energetic electrons can be employed for such diverse purposes as polymerizing a moving web or sheet and the drying or curing of inks and other liquids on a moving substrate. Such systems have also been employed for the surface and bulk sterilization of materials in a moving production line. Even further widespread use of the physical limitations which accompany suchapparatus by virtue of the nature of the energy source itself.

When electrons are used as the ionizing radiation, energy is often times dissipated from the irradiated web or sheet in the form of penetrating x-rays (bremsstrahlung) and through the molecular excitation of the materials characteristic x-rays from the atoms of the materials with which the electrons interact. The resultant source of penetrating x-ray or photon radiation is difficult to confine due to its great abaility to penetrate solid matter. As a consequence, on-line continuous application of electron curing has heretofore been limited in its application.

Although vault shielding of an entire system has been successfully used in the past, such approaches tend to be impractical when providing an apparatus for irradiating a flexible moving web or sheet. U.S. Patent No. 4,252,413 presents one approach to this problem by providing shielded cavity trap means at the inlet and outlet regions of a central irradiation zone through which a moving web or sheet is caused to pass. In further characterizing this prior art reference, it is noted that parallel shielded wall surfaces are employed which form longitudinally extending slots which collimate the spurious radiation, said slots further providing entry and exit regions for the moving web.

Although invention described in U.S. Patent No. 4,252,413 presents a reasoned approach for the use of apparatus capable of providing ionizing radiation to a moving web or sheet, certain difficulties remain unsolved which continue to restrict the universal acceptance of such devices, generally. The most prominent drawback is the heretofore rigidity of prior irradiation producing apparatus. Because of the need for shielding the ambient surroundings from penetrating spurious radiation, the physical geometry of prior apparatus, including that disclosed in U.S. Patent No. 4,252,413, was caused to be rigid and fixed. Thus, when a processing line carrying a moving web or sheet to be irradiated was changed resulting in an alteration of the special positioning of the web or sheet entering or exiting the radiation producing apparatus, the entire apparatus would either have to be discarded in favor of a newly conforming structure or substantially modified at great expense to accommodate the newly positioned moving web or sheet. Naturally, this lack in flexibility represented a substantial impediment to the use of prior ionizing radiation producing apparatus.

It is thus an object of the present invention to provide an apparatus which is free of the limitations and drawbacks of the prior art.

It is yet another object of the present invention to provide such an apparatus which possesses a degree of flexibility which has been heretofore unachievable.

These and other objects of the present invention will be readily perceived when considering the following disclosure and appended drawing which is a cross-sectional plan view of an apparatus for providing ionizing irradiation produced pursuant to the teachings of the present invention.

Summary of the Invention

An apparatus is provided for producing ionizing radiation to a moving web or sheet comprising a central chamber which includes a radiation trap and means for generating and directing ionizing radiation to said moving web or sheet. The improvement provided by the present invention comprises inlet and outlet means for the passage of the moving web or sheet, said inlet and outlet means being characterized as comprising one or more subchambers, each at the inlet and outlet sides of the central chamber. The subchambers contain means for trapping spurious ionizing radiation while being further characterized as being removable from the adjacent subchambers and central chamber. By being so removable, the subchambers are capable of being replaced with additional subchambers for altering the entrance and exit angles of the moving web or sheet in relation to the spacial positioning of the apparatus.

Detailed Description of the Invention

In reference to the appended figure, paramount to the present invention is the transport of moving web or sheet 12 within central chamber 10 which embraces an irradiation zone such as electron generator 11 completely enclosed within shielding 9, such as steel or lead, which has proven effective in confining penetrating photons inherently produced during the practice of the present invention. Ideally, such apparatus is also provided with a radiation trap depicted as element 3 in the appended drawing. The trap, being in direct line of the ionizing radiation passing through moving web 12 should possess a material which is capable of trapping substantial amounts of radiation from penetrating to the ambient surroundings, while also possessing the attributes of a good heat conductor as trap area 3 does tend to receive more energy than the remaining surface regions of the apparatus. Copper is suggested as a preferred material

for use in radiation trap 3 which can be water-cooled via ducts 4 as a further aid in dissipating the heat energy resulting from the impinging ionizing radiation.

In practice, web 12 is shown as entering subchamber 19, over roller 13 at which point the web enters subchamber 20. From that point, the web is caused to traverse about roller 14 at which point it enters central chamber 10, where irradiation takes place.

It is often times necessary to minimize the oxygen level within the chamber to reduce scavenging of free radicals in the chemistry to be cured near or at the surface of the moving web or sheet and to limit the generation of ozone by secondary reflections and scatter of the ionizing radiation. This can be accomplished by providing exhaust strippers 24 which act to strip from the moving web or sheet a substantial quantitiy of oxygen and related gases which are physically drawn along the web from the ambient surroundings. The stripped gases can be vented via conduit 26 and either trapped or otherwise disposed of in any well recognized manner. To further aid in the elimination of oxygen from central chamber 10 plenums 25 are provided for the introduction of an inert gas such as nitrogen in preferably a countercurrent flow pattern to the direction of the moving web 12. Between the strippers and inert gas introduction, virtually all of the significant ambient gases associated with the moving web are removed. It is noted that similar stripping and plenum devices can be located down-stream in any of the subchambers including subchamber 22 to prevent oxygen from creeping into chamber 10.

As a further preferred embodiment, the present invention contemplates providing access doors 30 on one or more of the subchambers. Not only are said access doors useful in enabling a user of the device to service the same, but they are helpful in enabling a threading of the running web or sheet through the apparatus at the beginning of a production run. Ideally, each access door would be hinged at one end, such as end 31, and releasably attached to a second end, i.e. 32. Sufficient seals would be provided to maintain the interior integrity of the device so that spurious ionizing irradiation would not escape and oxygen would not leak into the central chamber therethrough.

Yet another feature of the present invention is the provision of trap 35 which functions as a structural wall of central chamber 10, which is removable along the geometric center line of the central chamber to a position as shown in phamtom by reference numeral 35A. Such a configuration allows immediate and unencumbered access to the central chamber for servicing the interior elements and for threading the web or sheet through the unit. Further, trap 35 can be replaced with auxiliary components including, for example, chill or festooning rolls with the necessary shielding and guide rolls in conjunction with the presently depicted apparatus without modifying any further structural components. Trap 35 can be maintained integral to the exterior wall 9 of the central chamber via any convenient fastening means as long as a seal is maintained at edges 36 and 37 to prevent the inadvertent escape of spurious radiation and the leakage of oxygen to the processing area.

As a further aid in limiting the levels of oxygen and other unwanted gases from the interior of central chamber 10 is the provision of plenums 50 and exhaust means 40. The plenums act ot introduce inert gas, such as nitrogen, to the interior of the central chamber which, ideally, passes in a countercurrent path to the moving web or sheet and which is evactuated from the interior of said central chamber via the previously recited exhaust means 40. In a properly functioning operating mode, such apparatus is capable of maintaining the oxygen level within the central chamber below approximately 50 ppm during a steady state operation of the device.

The present invention is intended to operate with a minimum radiation leakage to the ambient surroundings. Leakage of less than 0.06 mR/hr. can be achieved by employing the present apparatus with one or more subchambers proximate the inlet and outlet means 17 and 18 of subchamber 10 which include elements 60, 60a, 61, 61a, 62, 62a, 63, 63a, etc. which are substantially parallel protrusions from the inner wall of one or more of the subchambers. These protrusions act to collimate and trap spurious radiation before its leakage to the ambient surroundings. Corresponding trapping means 70, 70a, 71, 71a, 72, 72a, 73, and 73a, are also shown within sub chhcamber 21 on the downside end of the present apparatus.

It is essential to the practice of the present invention that removable access means 35 be capable of being withdrawn from the apparatus to a position such as that shown as phantom 35a without the need for removing any of the subchambers described above. Conversely, the entry/exit web geometry can be altered by removing one or more of the subchambers and replacing them with subchambers of a different geometry in a simple bolt-off/bolt-on process without disturbing the central chamber including removable access means 35.

The flexibility inherent in practicing the present invention has been unavailable with prior devices. Not only does such a physical configuration allow for a repositioning of entry and exit paths without disturbing the central chamber and its supporting apparatus, but the central chamber itself can be altered in its spacial positioning without disturbing said entry and exit paths whatsoever. For example, it has been found that it is easier to thread a moving web or sheet through the central chamber if the chamber is positioned so that the web travels in a substantially vertical path, i.e. if the longitudinal direction of web 12 passing beneath the stream of ionizing radiation is vertical. Thus, by simply modifying the geometry of the various subchambers, the web can be caused to travel in such a vertical path without disturbing the inlet and outlet directions of the moving web as it emanates from and is fed to various pieces of supporting apparatus.

The flexibility inherently achieved in practicing

the present invention can also be employed to cascade several central or ionizing radiation producing chambers together in a single system, again, without altering the geometry of support equipment. For example, two chambers such as that depicted as element 10 in the appended drawing can be cascaded by connecting the outlet means of a first chamber with a subchamber, while the outlet of the subchamber feeds the inlet of yet a second processing chamber.

To further aid in the threading of the present apparatus, it is contemplated that one or more of the subchambers be provided with access means such as that shown as phantom element 30, which, during the operation of the present device, becomes a longitudinally oriented side wall of subchamber 21. In its preferred embodiment, longitudinal wall 30 is hinged at 31 which can be opened to enable the threading of web 12 over rollers 5, 15, etc. When closed, female protrusion 32 is taught to engage male protrusion 33 forming an integral seal which enhances the prevention of radiation leakage to the ambient surroundings and oxygen leakage to the interior of the apparatus. Although a single access means is depicted in the appended figure, it is contemplated, in practicing the present invention, that each of the subchambers can be optionally configured to possess said access means.

Further modifications to the present invention will occur to those skilled in this art, and such are considered to fall within the spirit and scope of the present invention as defined in the appended claims.

CLAIMS

1. An apparatus for providing ionizing radiation to a moving web or sheet comprising:

A. a central chamber which includes

(i) means for generating and directing ionizing radiation to said moving web or sheet;

(ii) a radiation trap for absorbing substantial quantities of radiation which remains unabsorbed by the web or sheet and for dissipating heat generated by said radiation;

(iii) removable access means to allow entry to the interior of said chamber; and

(iv) inlet and outlet means for accepting and discharging said moving web or sheet through said central chamber;

B. one or more subchambers functionally appended to said central chamber being characterized as comprising;

(i) means for trapping spurious radiation emanating from said inlet and oulet means of said central chamber; and

(ii) guiding means for supporting the moving web or sheet through said apparatus, wherein said one or more subchambers are removable from the central chamber and from other subchambers without the removal of said access means.

2. The apparatus of claim 1 further comprising means for limiting oxygen levels within the central chamber.

3. The apparatus of claim 1 wherein at least one subchamber proximate the inlet side of said central chamber further comprises means for stripping oxygen from said moving web or sheet.

4. The apparatus of claim 3 wherein said stripping means comprises plenum means for the introduction of an inert gas and exhaust means for venting said inert gas and any other gases carried by the moving web or sheet.

5. The apparatus of claim 4 wherein said plenum means is located downstream of said exhaust means so that said inert gas is caused to travel countercurrent to the direction of travel of said moving web.

6. The apparatus of claim 4 wherein said inert gas is nitrogen.

7. The apparatus of claim 1 wherein said access means is removable from said central chamber without the removal of any of the subchambers.

8. The apparatus of claim 2 wherein said means for limiting oxygen levels within said central chamber comprise a plenum for the introduction of an inert gas within said central chamber and exhaust means for substantially evacuating any gases found within said central chamber.

9. The apparatus of claim 1 further comprising means for cooling said radiation trap.

10. The apparatus of claim 8 wherein said cooling means comprises water circulation means.

11. The apparatus of claim 1 wherein each subchamber includes access means for providing entry to the interior of said subchamber.

12. The apparatus of claim 10 wherein said access means comprises a hinged wall wherein said wall is located along a longitudinal axis of the subchamber.

13. The apparatus of claim 1 wherein the oxygen level within the central chamber is maintained below approximately 50 ppm during a steady state operation of said apparatus.

14. The apparatus of claim 1 wherein said subchambers are replaceable with additional subchambers for altering the entrance or exit angles of the moving web or sheet in relation to the spacial positioning of said apparatus.

15. Apparatus for providing ionizing radiation to a moving web or sheet, such apparatus being constructed and arranged to operate substantially as hereinbefore described with reference to and as illustrated in the accompnying drawings.

Printed in the UK for HMSO. D8818935, 8-85. 7102.
Published by The Patent Office, 25 Southampton Buildings, London, WC2A 1AY, from which copies may be obtained.